FIG. **9** shows a perspective view of an electronic device.

FIG. **10**A shows a perspective view of a portion of a three-dimensional structure.

FIG. **10**B shows a top view of the portion of a three-dimensional structure.

FIG. **10**C shows a rear view of the portion of the three-dimensional structure of FIG. **10**B.

FIG. **10**D shows a front view of the portion of the three-dimensional structure of FIG. **10**B.

FIG. **10**E shows a cross-sectional view of the portion of the three-dimensional structure of FIG. **10**B.

FIG. **10**F shows a perspective view of the spherical recesses of the three-dimensional structure of FIG. **10**B.

FIG. **11** shows a perspective view of a portion of a three-dimensional structure.

FIG. **12** shows a top view of the three-dimensional structure of FIG. **11**.

FIG. **13** shows a side view of the three-dimensional structure of FIG. **11**.

FIG. **14** shows a sectional view of the three-dimensional structure of FIG. **11**.

FIG. **15** shows a sectional view of an electronic device including a three-dimensional structure.

FIG. **16** shows a perspective view a three-dimensional structure for an electronic device.

FIG. **17** shows a back view of a three-dimensional structure including a comparative thermal map showing heat flow in a three-dimensional structure and a solid body.

FIG. **18** shows a sectional view of a stage of a process for forming a three-dimensional structure.

FIG. **19** shows a sectional view of a stage of a process for forming a three-dimensional structure.

FIG. **20** shows a sectional view of a stage of a process for forming a three-dimensional structure.

FIG. **21** shows a sectional view of a three-dimensional structure formed according a process.

DETAILED DESCRIPTION

Representative embodiments are illustrated in the accompanying drawings. The following descriptions are not intended to limit the embodiments to one preferred embodiment. To the contrary, they are intended to cover alternatives, modifications, and equivalents as can be included within the spirit and scope of the described embodiments as defined by the appended claims.

The present structure includes a housing or other component including regions of a three-dimensional structure. The three-dimensional structure can include spherical recesses that interfere with each other to create through holes arranged in specified patterns. The spherical recesses can have a base form of three spherical recesses in a common plane that at least partially intersect or interfere with one another, and a fourth spherical recess on an adjacent plane that intersects or interferes with each of the three spherical recesses. This base form can then be propagated or repeated throughout the structure to form the aggregate three-dimensional structure. The present three-dimensional structures, for example when included as a portion or region of a housing, can provide a number of desirable attributes or properties to the housing. Specifically, a housing including a structure as described herein can provide enhanced heat removal compared to traditional housings. For example, a housing including the present structures can maximize both surface area and aperture distribution for thermal transfer, while maintaining a robust structural lattice. That is, a housing including the present structures can optimize its ability to distribute or remove heat from an electronic device while remaining both light and strong, thereby improving performance of the electronic device compared to traditional monolithic or closed contiguous structures. In some cases, the structure as described herein can be included as one or more portions or regions of a housing or other components of an electronic device. In some other cases, however, the structure can form substantially all of the housing and/or other components of an electronic device.

The three-dimensional structure or structures included as a portion or region of a housing for an electronic device can include a body defining a first surface and a second surface. In some examples, the body can be a unitary body, for example a unitary body formed by a single piece, section, or portion of a material. In some examples, however, the body can be formed from, or can include, two or more portions that can be joined together to form the body, for example by welding, adhering, or bonding. In some examples, one or more cavities, or portions of cavities, can be formed in separate portions of material, whereupon the portions of material can be joined to form a body including patterns of cavities, as described herein. The first surface and the second surface of the body can be opposing surfaces. At least a portion of the body can include a three-dimensional pattern or matrix of apertures or passageways therein. In some embodiments, the three-dimensional pattern can extend through at least a portion or region of the body or substantially throughout the entire body. The three-dimensional pattern can extend across one or more of an entire height, width, and depth of the body. The three-dimensional pattern or matrix can be formed or defined by a combination of one or more cavities extending into the body from the first surface and one or more cavities extending into the body from the second surface of the body.

In some embodiments, the one or more cavities extending into the body from the first surface can intersect with one or more of the cavities extending into the body from the second surface, to form the three-dimensional pattern or matrix. That is, in some cases, the negative space of a cavity extending into the body from the first surface of the body can intersect or interfere with the negative space of one or more cavities extending into the body from the second surface of the body. Further, in some embodiments, the cavities can eccentrically intersect, merge, or interfere to form an aperture. The aperture or apertures can be through-holes in the body, that is, as used herein, the term aperture can refer to a hole in a body that passes entirely through the body. In some embodiments, the three-dimensional pattern of apertures as described herein can have a surface area that is up to twice as large, up to five times as large, up to ten times as large, or even several orders of magnitude larger than the surface area of a similarly sized and shaped body that does not include the three-dimensional pattern of apertures. This high amount of surface area can serve to greatly increase the ability of the body to transport heat away from itself or away from other components of an electronic device in contact with the body, for example, by direct convection to the surrounding air. In some embodiments, the cavities extending into the body from a surface of the body can be arranged in a pattern. This pattern can be a regular or repeating pattern of cavities that extends throughout a portion of a surface, or in some cases substantially an entire surface of the body.

The structures described herein, such as the three-dimensional structures for electronic devices, can provide for enhanced heat removal compared to traditional three-dimensional structures. For example, a three-dimensional structure acting as a housing for an electronic device can remove